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A new species of *Pseudopoda* (Araneae, Sparassidae) from China, with the description of different and distinctive internal ducts of the female vulva

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Abstract

One new species of the genus *Pseudopoda* Jäger, 2000, *Pseudopoda deformis* Gong & Zhong, **sp. nov.** (♂, ♀), is described and documented with digital images from Shennongjia Forestry District, Hubei Province, China, based on morphology and DNA barcodes. This new species is separated from other *Pseudopoda* species by the unique type of internal ducts of the female vulva that are curved longitudinally, forming a narrow triangle or trapezoidal shape. In addition, DNA barcodes for this species are provided.

Keywords

DNA barcoding, Hubei, huntsman spiders, morphology, taxonomy

Introduction

Pseudopoda Jäger, 2000 is currently the largest genus in the family Sparassidae Bertkau, 1872. It comprises 251 species, of which 152 are recorded from China, representing 60.6% of the global species (WSC 2023). The genus has been recorded in areas from

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South Asia (49 species in Nepal, India, Bhutan, and Pakistan), East Asia (154 species in China and Japan) and Southeast Asia (50 species in Myanmar, Thailand, Laos, and Vietnam) (WSC 2023).

While examining specimens recently collected from Shennongjia Forestry District of Hubei Province, central China, we found some huntsman spiders. The spiders described in this paper were identified as a new species based on comparison with other *Pseudopoda* species. The male palp of this new species has a slender embolus, and the female vulva has unique internal ducts. We used DNA barcodes of the species to match the sexes and for future use in identification.

Material and methods

Specimens were examined and measured with an Olympus SZX7 stereomicroscope. Positions of tegular appendages are given according to clock positions, based on the left palp in ventral view. Male and female copulatory organs were examined and illustrated after dissection from the spider bodies; vulvae were cleared in a warm 10% potassium hydroxide (KOH) solution. All photographs were captured with a KUY NICE industrial digital camera (20.0 megapixels) mounted on an Olympus CX43 dissecting microscope and assembled using Helicon Focus 3.10.3 image stacking software. Photographic images were then edited using Adobe Photoshop CC 2018. All measurements were obtained using an Olympus SZX7 stereomicroscope and are given in millimetres (mm).

Leg measurements are shown as: total length (femur, patella, tibia, metatarsus, tarsus). Number of macrosetae is listed for each segment in the following order: prolateral, dorsal, retrolateral, ventral; in femora and patellae ventral spines are absent and thus the fourth article is omitted in the setation formula (Gong and Zhong 2020).

Abbreviations used in the text and figures are given below: **ALE** = anterior lateral eye, **AME** = anterior median eye, **AW** = anterior width of carapace, **C** = conductor, **CO** = copulatory opening, **CH** = clypeus height, **dRTA** = dorsal branch of RTA, **E** = embolus, **FD** = fertilisation duct, **Fe** = femur, **LL** = lateral lobes, **Mt** = metatarsus, **OL** = opisthosoma length, **OW** = opisthosoma width, **Pa** = patella, **PI** = posterior incision of LL, **PL** = carapace length, **PLE** = posterior lateral eyes, **PME** = posterior median eyes, **Pp** = palp or palpus, **PW** = carapace width, **RTA** = retrolateral tibial apophysis, **Sp** = spermophor, **T** = tegulum, **Ta** = tarsus, **Ti** = tibia. I, II, III, IV—legs I to IV, **vRTA** = ventral branch of RTA, **HUST** = School of Nuclear Technology and Chemistry and Biology, Hubei University of Science and Technology, Xianning, Hubei, China.

To obtain DNA barcodes, one mitochondrial gene (mitochondrial cytochrome oxidase subunit I [COI]) and one nuclear gene (Internal Transcribed Spacer 2 [ITS2]) were amplified and sequenced for four specimens. Primers (Folmer et al. 1994), PCR conditions and other information (e.g., extraction, amplification and sequencing procedures) are the same as in Zhang et al. (2021). The accession numbers are provided in Table 1. For phylogenetic inference, we used the dataset (COI + ITS2) from Cao

et al. (2016) and added the new sequences of *Pseudopoda deformis* Gong & Zhong, sp. nov. Phylogenetic analyses are the same as in Cao et al. (2016) and Zhang et al. (2017). Bayesian inference strongly supported the monophyly of the *P. deformis* Gong & Zhong, sp. nov. (Fig. 5).

Table 1. Information on newly sequenced *Pseudopoda deformis* Gong & Zhong, sp. nov. with GenBank accession numbers.

Voucher code	Sex	COI	ITS2
HUST-SPA-22-001	♂	OQ788976	OQ797662
HUST-SPA-22-002	♀	OQ788977	OQ797663
HUST-SPA-22-003	♀	OQ788978	OQ797664
HUST-SPA-22-004	♀	OQ788979	OQ797665

Taxonomy

Family Sparassidae Bertkau, 1872
Subfamily Heteropodinae Thorell, 1873

Genus *Pseudopoda* Jäger, 2000

Type species. *Sarotes promptus* O. Pickard-Cambridge, 1885.

Diagnosis (updated). *Pseudopoda* was defined by Jäger (2000) according to the following combination of characters: male palp (Fig. 1A–C) with membranous conductor or absent, embolus arising on the left side of the tegulum and generally curved, RTA arising from tibia, basally or mesially and furcate or not; epigyne (Fig. 2A–C) with lateral lobes extending beyond epigastric furrow, and generally covering median septum (modified from Jäger 2000; Zhang et al. 2013; Jiang et al. 2018).

Distribution. Bhutan, China, Nepal, India, Japan, Laos, Myanmar, Pakistan, Thailand and Vietnam.

Pseudopoda deformis Gong & Zhong, sp. nov.

https://zoobank.org/1F62E2C1-3556-4B86-AE30-D907B4F204CB
(变形拟遁蛛)
Figs 1–5

Type material. ***Holotype*** **#m: China:** Hubei Province: Shennongjia Forestry District, Muyu Town, Guanmenshan Scenic Area (31.45°N, 110.40°E, 1200 m a.s.l.), 10.XII.2021, leg. Y. Zhong (HUST-SPA-22-001). ***Paratypes*****: China:** Hubei Province: Same locality, 1#f (HUST-SPA-22-002), 1#f (HUST-SPA-22-003), 1#f (HUST-SPA-22-004), 3#m, 4#f.

Etymology. The specific name is derived from the Latin word *deformis*, *-a*, *-um*, meaning distorted, referring to the shape of the internal ducts of the female vulva.

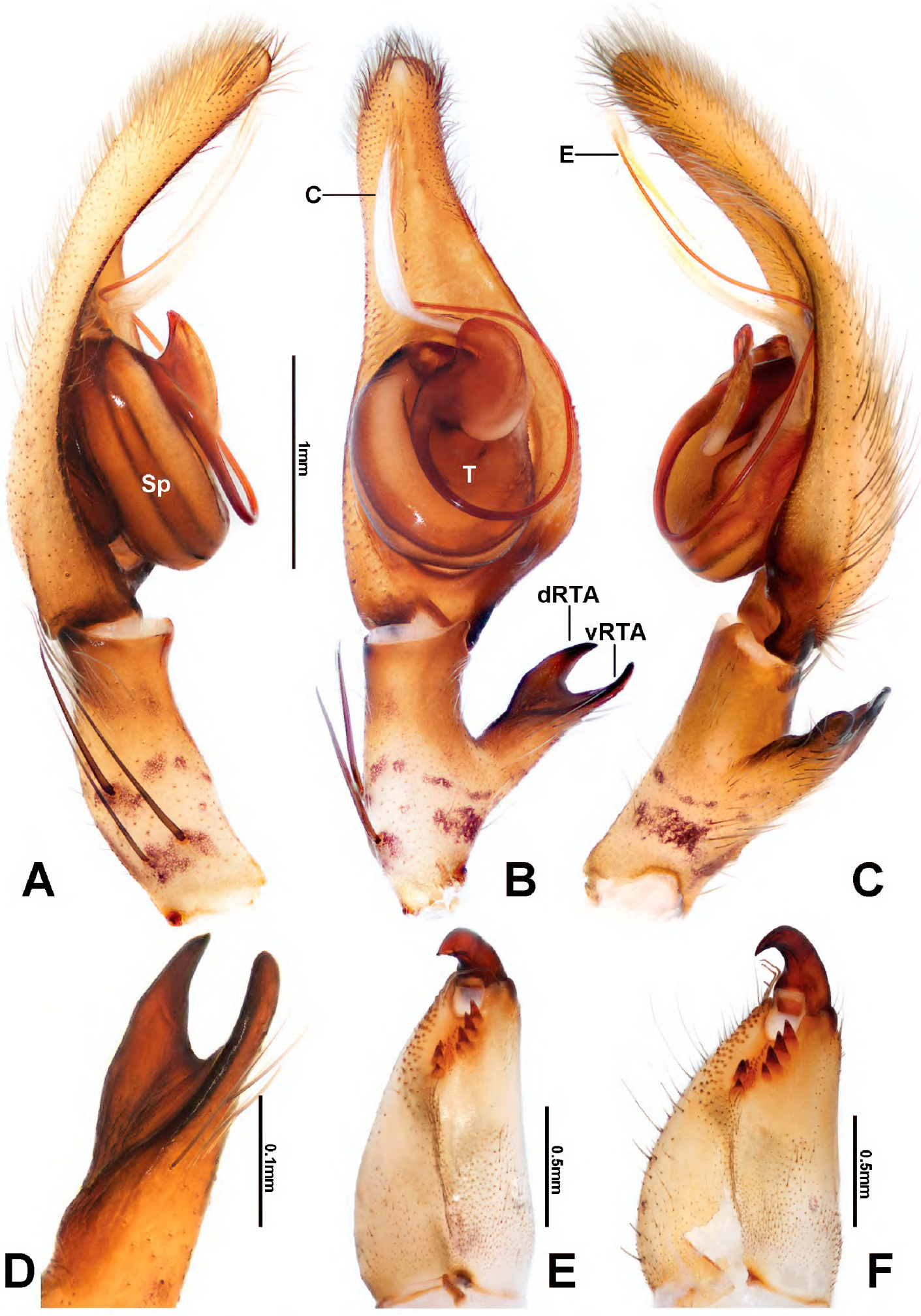

Figure 1. *Pseudopoda deformis* Gong & Zhong, sp. nov., male holotype (HUST-SPA-22-001), left palp (**A–C**), left male palpal tibia (**D**), and cheliceral dentition (**E, F**). **A** prolateral view **B** ventral view **C, D** retrolateral view **E** male, ventral view **F** female, ventral view. Abbreviations: C = conductor; dRTA = dorsal branch of RTA; vRTA = ventral branch of RTA; E = embolus; Sp = spermophore; T = tegulum. Scale bars: 1 mm (**A–C**); 0.1 mm (**D**); 0.5 mm (**E, F**).

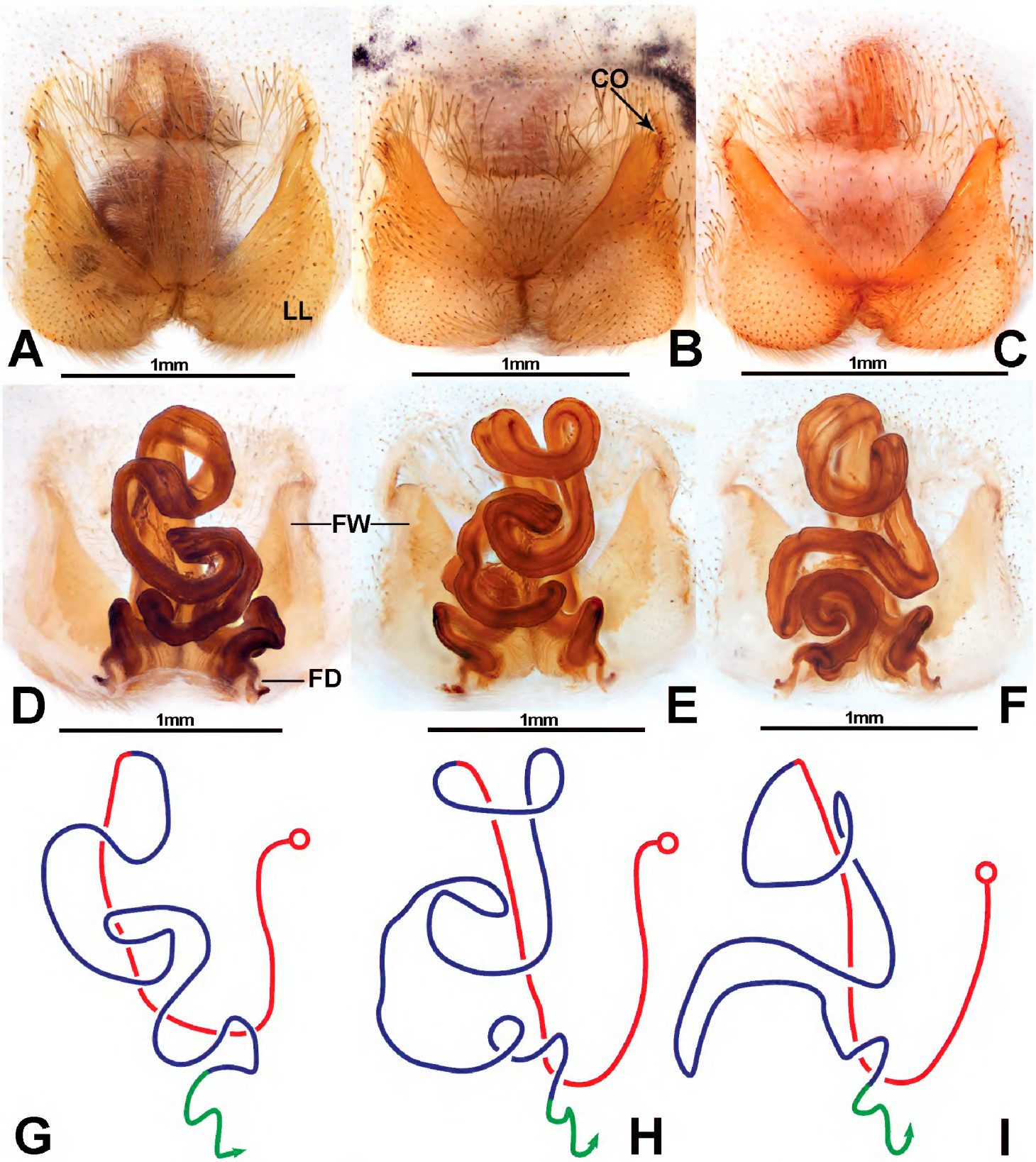

Figure 2. *Pseudopoda deformis* Gong & Zhong, sp. nov., female paratype (**A, D** HUST-SPA-22-002; **B, E** HUST-SPA-22-003; **C, F** HUST-SPA-22-004), epigyne (**A–C**), vulva (**D–F**), and schematic course of internal duct system (**G–I**). **A–C** ventral view **D–F** dorsal view. Abbreviations: CO = copulatory opening; FD = fertilisation duct; FW = first winding; LL = lateral lobes. Scale bars: 1 mm (**A–F**).

Diagnosis. Males of *Pseudopoda deformis* Gong & Zhong, sp. nov. are similar to those of *P. jiangi* Zhang, Jäger & Liu, 2023 (Zhang et al. 2023: figs 130, 131), *P. lushanensis* (Wang, 1990) (Quan et al. 2014: figs 4A–C, 5A–C) and *P. shuqiangi* Jäger & Vedel, 2007 (Jäger and Vedel 2007: figs 73–75) in having a long, filiform embolus. They can be distinguished from the two congeners by the following combination of characters: (1) Embolus arising from tegulum at 1:00-o'clock position, then curving

downward (8:30-o'clock position, upward in *P. lushanensis* and *P. shuqiangi*); (2) The basal part of embolus is oval (circular in *P. jiangi*); (3) The tip of the conductor is straight and extends to approximately the tip of the cymbium in ventral view (not in *P. lushanensis* and *P. shuqiangi*); and (4) RTA arising medially from tibia (subdistally in *P. lushanensis*; basally in *P. shuqiangi*) (Fig. 1A–C). The females of this species

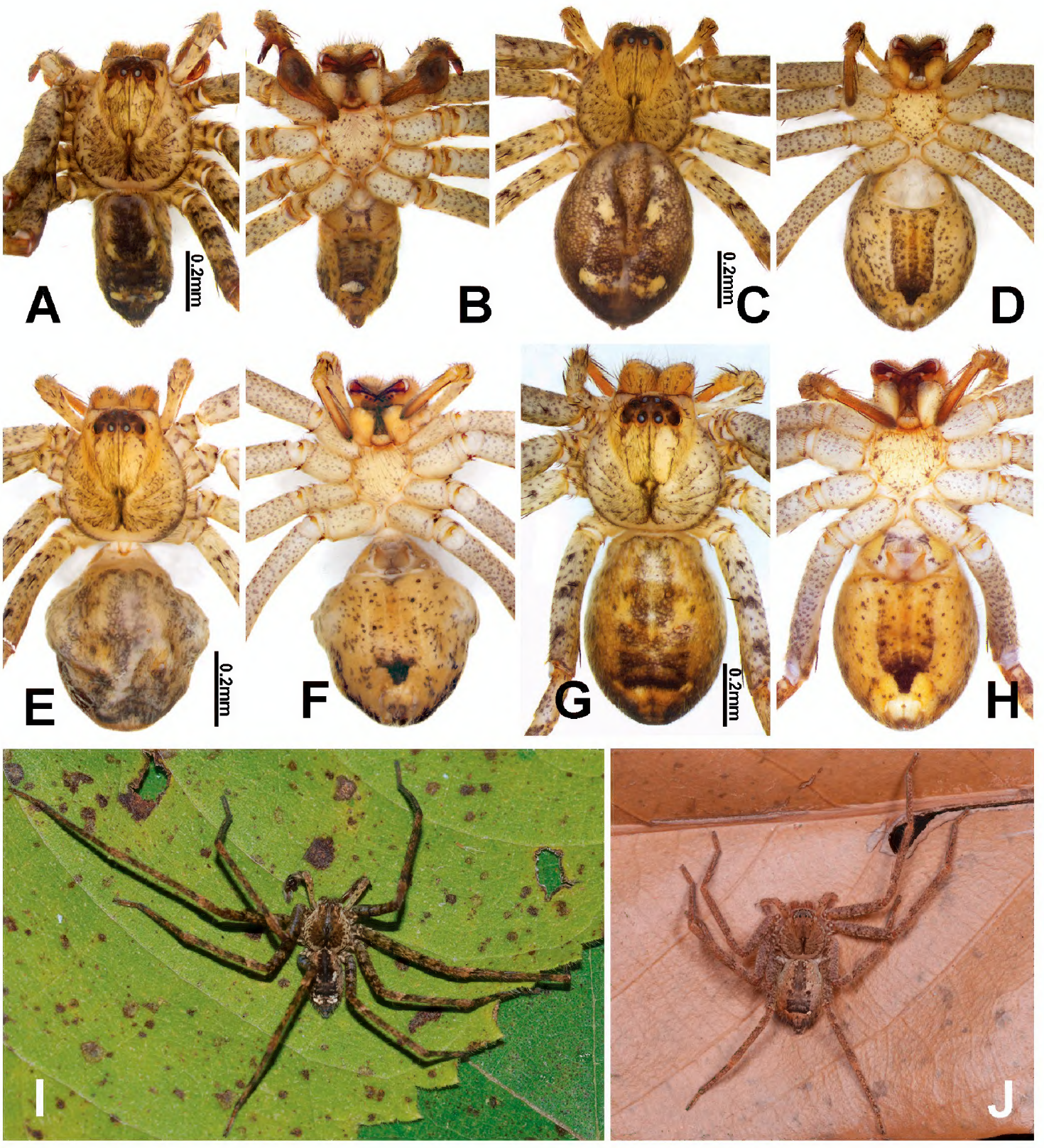

Figure 3. *Pseudopoda deformis* Gong & Zhong, sp. nov., habitus (**A–H**), and live specimens (**I, J**) **A, I** (HUST-SPA-22-001), holotype male, dorsal view **B** (HUST-SPA-22-001), holotype male, ventral view **C, J** (HUST-SPA-22-002), paratype female, dorsal view **D** (HUST-SPA-22-002), paratype female, ventral view **E** (HUST-SPA-22-003), paratype female, dorsal view **F** (HUST-SPA-22-003), paratype female, ventral view **G** (HUST-SPA-22-004), paratype female, dorsal view, **H** (HUST-SPA-22-004), paratype female, ventral view. Scale bars: 0.2 mm (**A–H**).

can be separated from other *Pseudopoda* species by their unique internal ducts of the vulva, which are curved longitudinally, forming a narrow triangle or trapezoidal shape (Fig. 2D–I).

Description. Male. PL 4.9, PW 3.4, AW 2.3, OL 4.6, OW 3.4. Eyes: AME 0.24, ALE 0.26, PME 0.27, PLE 0.33, AME–AME 0.21, AME–ALE 0.12, PME–PME 0.23, PME–PLE 0.16, AME–PME 0.29, ALE–PLE 0.18, CH AME 0.27, CH ALE 0.33. Setation: Palp: 131, 101, 2101; Fe: I–III 323, IV 321; Pa: I–IV 101; Ti: I–II 2228, III–IV 2126; Mt: I–II 2024, III 2026, IV 3036. Measurements of palp and legs: Palp 7.4 (2.1, 0.9, 1.3, –, 3.1), I 27.0 (7.1, 1.5, 8.2, 7.8, 2.4), II 29.6 (7.8, 1.5, 8.8, 8.9, 2.6), III 21.6 (6.0, 1.3, 6.1, 6.3, 1.9), IV 24.5 (6.5, 1.3, 6.9, 7.6, 2.2). Leg formula: II-I-IV-III. Chelicerae with three promarginal and four retromarginal teeth, and with ~51 denticles (Fig. 1E). Carapace yellowish brown dorsally, margin with black patches, with shallow fovea and radial furrows. Chelicerae deep reddish brown. Sternum yellow with lots of random black spots. Endites and labium pale yellowish brown. Legs brown, with dark dots randomly distributed and covered by short spines and seta. Opisthosoma black-brown dorsally, without spots. Opisthosoma uniformly yellowish brown with some black patches ventrally (Fig. 3A, B).

Cymbium approximately 2 times longer than tibia (Fig. 1A–C). The basal part of conductor is obscured in ventral view (Fig. 1B) by embolus base. Basal part of conductor slightly sclerotized (Fig. 1C). Embolus slender, encircling the tegulum counterclockwise, ventrally pointed (Fig. 1B). RTA distally bifurcate, pincer-shaped in ventral view, dRTA moderately pointed at tip (Fig. 1B, D).

Female. PL 5.0, PW 4.8, AW 2.8, OL 6.7, OW 4.7. Eyes: AME 0.25, ALE 0.34, PME 0.26, PLE 0.38, AME–AME 0.18, AME–ALE 0.08, PME–PME 0.24, PME–PLE 0.18, AME–PME 0.29, ALE–PLE 0.17, CH AME 0.35, CH ALE 0.45. Setation: Palp: 131, 101, 2121, 1014; Fe: I–III 323, IV 321; Pa: I–IV 000; Ti: I–II 222(10), III–IV 2126; Mt: I–II 2024, III–IV 2026. Measurements of palp and legs: Palp 6.4 (2.1, 0.7, 1.0, –, 2.6), I 19.3 (5.5, 1.3, 5.6, 5.1, 1.8), II 20.5 (5.9, 1.3, 6.1, 5.4, 1.8), III 15.4 (4.6, 1.1, 4.5, 3.7, 1.5), IV 17.0 (5.0, 1.1, 4.5, 4.6, 1.8). Leg formula: II-I-IV-III. Chelicerae with three promarginal and four retromarginal teeth, and with ~46 denticles (Fig. 1F).

Epigynal field almost as wide as long, the anterior margins of lateral lobes forming a V-shape, median margin of lateral lobes united, internal duct systems not visible through cuticle, fertilisation ducts arising postero-laterally. In the dorsal view, internal duct systems differ extremely, and there is no regularity in the direction and structure of internal pipeline (Fig. 2).

Colouration as in males, opisthosoma brown dorsally (Fig. 3C–H).

Habitat. The specimens were collected on leaves at night with bare hands (Fig. 4A, B).

Distribution. Known only from Hubei Province, China (Fig. 4C).

Remarks. The monophyly of *Pseudopoda deformis* Gong & Zhong, sp. nov. is highly supported by molecular phylogenetic results based mainly on Chinese *Pseudopoda* species (Fig. 5).

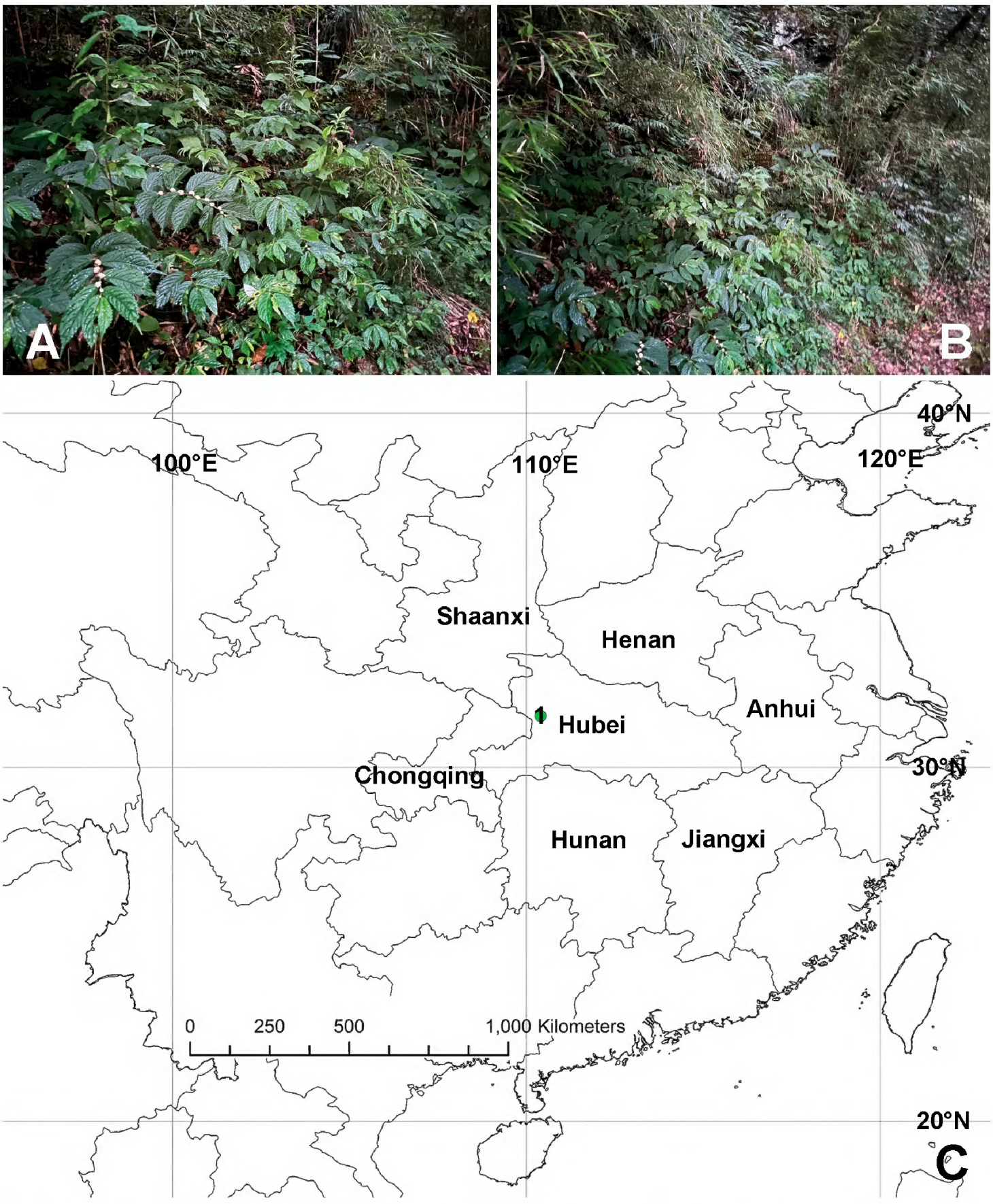

Figure 4. Photograph of the habitat (**A, B**) and collection locality of *Pseudopoda deformis* Gong & Zhong, sp. nov. (**C**).

Discussion

We examined all specimens from Shennongjia (4 males, 7 females) and found no variation in the male palp. However, the females had different internal ducts in their vulva, which is not known to occur in other *Pseudopoda* spiders. In this paper, matching of the sexes of *Pseudopoda deformis* Gong & Zhong, sp. nov. was done using morphological and molecular data (Figs 3, 5). Females of this species resemble most *Pseudopoda*

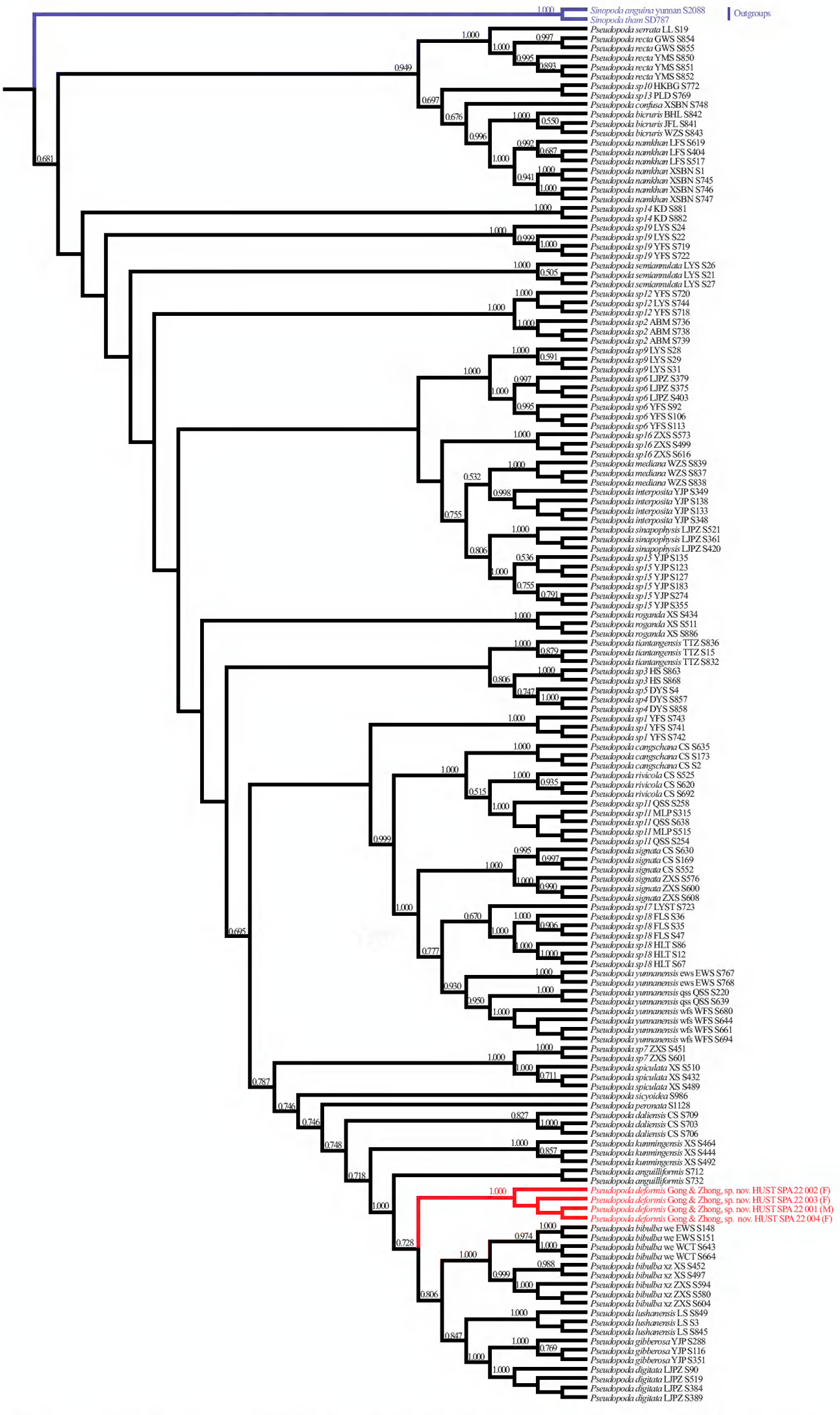
Outgroups
Sinopoda anguina yunnan S2088
Sinopoda tham SD787
Pseudopoda serrata LL S19
Pseudopoda recta GWS S854
Pseudopoda recta GWS S855
Pseudopoda recta YMS S850
Pseudopoda recta YMS S851
Pseudopoda recta YMS S852
Pseudopoda sp10 HKBG S772
Pseudopoda sp13 PLD S769
Pseudopoda confusa XSBN S748
Pseudopoda bicruris BHL S842
Pseudopoda bicruris JFL S841
Pseudopoda bicruris WZS S843
Pseudopoda namkhan LFS S619
Pseudopoda namkhan LFS S404
Pseudopoda namkhan LFS S517
Pseudopoda namkhan XSBN S1
Pseudopoda namkhan XSBN S745
Pseudopoda namkhan XSBN S746
Pseudopoda namkhan XSBN S747
Pseudopoda sp14 KD S881
Pseudopoda sp14 KD S882
Pseudopoda sp19 LYS S24
Pseudopoda sp19 LYS S22
Pseudopoda sp19 YFS S719
Pseudopoda sp19 YFS S722
Pseudopoda semiannulata LYS S26
Pseudopoda semiannulata LYS S21
Pseudopoda semiannulata LYS S27
Pseudopoda sp12 YFS S720
Pseudopoda sp12 LYS S744
Pseudopoda sp12 YFS S718
Pseudopoda sp2 ABM S736
Pseudopoda sp2 ABM S738
Pseudopoda sp2 ABM S739
Pseudopoda sp9 LYS S28
Pseudopoda sp9 LYS S29
Pseudopoda sp9 LYS S31
Pseudopoda sp6 LJPZ S379
Pseudopoda sp6 LJPZ S375
Pseudopoda sp6 LJPZ S403
Pseudopoda sp6 YFS S92
Pseudopoda sp6 YFS S106
Pseudopoda sp6 YFS S113
Pseudopoda sp16 ZXS S573
Pseudopoda sp16 ZXS S499
Pseudopoda sp16 ZXS S616
Pseudopoda mediana WZS S839
Pseudopoda mediana WZS S837
Pseudopoda mediana WZS S838
Pseudopoda interposita YJP S349
Pseudopoda interposita YJP S138
Pseudopoda interposita YJP S133
Pseudopoda interposita YJP S348
Pseudopoda sinapophysis LJPZ S521
Pseudopoda sinapophysis LJPZ S361
Pseudopoda sinapophysis LJPZ S420
Pseudopoda sp15 YJP S135
Pseudopoda sp15 YJP S123
Pseudopoda sp15 YJP S127
Pseudopoda sp15 YJP S183
Pseudopoda sp15 YJP S274
Pseudopoda sp15 YJP S355
Pseudopoda roganda XS S434
Pseudopoda roganda XS S511
Pseudopoda roganda XS S886
Pseudopoda tiantangensis TTZ S836
Pseudopoda tiantangensis TTZ S15
Pseudopoda tiantangensis TTZ S832
Pseudopoda sp3 HS S863
Pseudopoda sp3 HS S868
Pseudopoda sp5 DYS S4
Pseudopoda sp4 DYS S857
Pseudopoda sp4 DYS S858
Pseudopoda sp1 YFS S743
Pseudopoda sp1 YFS S741
Pseudopoda sp1 YFS S742
Pseudopoda cangschana CS S635
Pseudopoda cangschana CS S173
Pseudopoda cangschana CS S2
Pseudopoda rivicola CS S525
Pseudopoda rivicola CS S620
Pseudopoda rivicola CS S692
Pseudopoda sp11 QSS S258
Pseudopoda sp11 MLP S315
Pseudopoda sp11 QSS S638
Pseudopoda sp11 MLP S515
Pseudopoda sp11 QSS S254
Pseudopoda signata CS S630
Pseudopoda signata CS S169
Pseudopoda signata CS S552
Pseudopoda signata ZXS S576
Pseudopoda signata ZXS S600
Pseudopoda signata ZXS S608
Pseudopoda sp17 LYST S723
Pseudopoda sp18 FLS S36
Pseudopoda sp18 FLS S35
Pseudopoda sp18 FLS S47
Pseudopoda sp18 HLT S86
Pseudopoda sp18 HLT S12
Pseudopoda sp18 HLT S67
Pseudopoda yunnanensis ews EWS S767
Pseudopoda yunnanensis ews EWS S768
Pseudopoda yunnanensis qss QSS S220
Pseudopoda yunnanensis qss QSS S639
Pseudopoda yunnanensis wfs WFS S680
Pseudopoda yunnanensis wfs WFS S644
Pseudopoda yunnanensis wfs WFS S661
Pseudopoda yunnanensis wfs WFS S694
Pseudopoda sp7 ZXS S451
Pseudopoda sp7 ZXS S601
Pseudopoda spiculata XS S510
Pseudopoda spiculata XS S432
Pseudopoda spiculata XS S489
Pseudopoda sicyoidea S986
Pseudopoda peronata S1128
Pseudopoda daliensis CS S709
Pseudopoda daliensis CS S703
Pseudopoda daliensis CS S706
Pseudopoda kunmingensis XS S464
Pseudopoda kunmingensis XS S444
Pseudopoda kunmingensis XS S492
Pseudopoda anguilliformis S712
Pseudopoda anguilliformis S732
Pseudopoda deformis Gong & Zhong, sp. nov. HUST SPA 22 002 (F)
Pseudopoda deformis Gong & Zhong, sp. nov. HUST SPA 22 003 (F)
Pseudopoda deformis Gong & Zhong, sp. nov. HUST SPA 22 001 (M)
Pseudopoda deformis Gong & Zhong, sp. nov. HUST SPA 22 004 (F)
Pseudopoda bibulba we EWS S148
Pseudopoda bibulba we EWS S151
Pseudopoda bibulba we WCT S643
Pseudopoda bibulba we WCT S664
Pseudopoda bibulba xz XS S452
Pseudopoda bibulba xz XS S497
Pseudopoda bibulba xz ZXS S594
Pseudopoda bibulba xz ZXS S580
Pseudopoda bibulba xz ZXS S604
Pseudopoda lushanensis LS S849
Pseudopoda lushanensis LS S3
Pseudopoda lushanensis LS S845
Pseudopoda gibberosa YJP S288
Pseudopoda gibberosa YJP S116
Pseudopoda gibberosa YJP S351
Pseudopoda digitata LJPZ S90
Pseudopoda digitata LJPZ S519
Pseudopoda digitata LJPZ S384
Pseudopoda digitata LJPZ S389

Figure 5. Bayesian tree based on the COI + ITS2 dataset including 146 *Pseudopoda* individuals belonging to 45 species. Numbers on nodes are posterior probabilities. Red clade indicates *Pseudopoda deformis* Gong & Zhong, sp. nov., blue clade indicates the outgroups.

species having the median margin of the lateral lobes converged medially with the anterior part V-shaped, but they can be distinguished from these species by the longitudinally bent internal duct system of the vulva (Fig. 2A–F). As shown in Fig. 2G–I, the female vulva is divided into three parts schematically to show the course of the internal duct system, leading to an interesting discovery. The first part is represented by a red line and is U-shaped in all three females examined. The third part is represented by a green line and is an inverted S-shaped. Variability occurs in the second part which is shown by the blue line, and there are irregularities to this variation.

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